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TITLE: NEW SCINTILLATORS FOR FIBER OPTICS: SYSTEM SENSITIVITY AND BANDWIDTH AS A FUNCTION OF FIBER LENGTH

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NEW SCINTILLATORS FOR FIBER OPTICS: SYSTEM SENSITIVITY AND BANDWIDTH AS A FUNCTION OF FIBER LENGTH*

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ABSTRACT

Long-wavelength liquid scintillators have been developed for fiber-optic plasma-diagnostic experiments. Relative system sensitivity and bandwidth data as a function of fiber length for several scintillator systems will be presented. This paper will be appropriate for the poster session.

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New Scintillators for Fiber Optics: System Sensitivity and Bandwidth as a Function of Fiber Length,* S. Lutz, L.A. Franks, and J.M. Flournoy, EG&G, Inc., Santa Barbara Operations, 130 Robin Hill Road, Goleta, CA 93117, (805) 967-0456, and P.B. Lyons, University of California, Los Alamos National Scientific Laboratory, P.O. Box 1663, Los Alamos, NM 87545.

Scintillators have been employed as radiation-to-light converters in plasma diagnostic experiments utilizing fiber optics.

Until recently, nanosecond and subnanosecond scintillators were available only in the near ultraviolet.[1] Optical and transmission properties of fiber optics both strongly favor longer wavelengths. More recently, subnanosecond scintillators with emission peaks around 480 nm have been reported.[2] Development work performed during the past year yielded several new scintillator systems with emission wavelengths more compatible with fiber optics and response times in the nanosecond and subnanosecond time region. One scintillator, based on Kodak dye #14567,[3] has an emission maximum near 700 nm and a response time (FWHM) of 1.9 ns. Another system, based on Coumarin-540A[4] has an emission maximum of 500 nm and a response time of 330 ps. A time-resolved plasma imaging experiment successfully fielded on nuclear device tests at the Nevada Test Site[5] utilized the blue-green scintillator, Liquid A,[6] as a radiation-to-light converter.

Figure 1 shows a calculated graph of system response time and dynamic range versus fiber length for our measurement system using Liquid A. These calculations are based on experimental measurements of fluor-fiber bandwidth and attenuation, performed through 500 meters of fiber optic. This graph is based on 62 μm graded-index fiber, 15 dB/km fiber attenuation at 540 nm, 1.5 ns/km modal dispersion, 430 ps/nm-km material dispersion, 3×10^{-16} J/rad fluorescent coupling efficiency into the graded-index fiber, and a peak dose rate fluor linearity of 7×10^{11} rads/s.

Based upon measurements relating the sensitivity of Liquid A to other scintillator systems, and published fiber parameters at wavelengths other than than 540 nm,[7] it is possible to calculate similar curves for other scintillator systems. Figure 2 shows the expected bandwidth and dynamic range for a fluor-

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fiber system operated at 700 nm, utilizing a previously described scintillator based upon Kodak dye #14567. This calculation is for 62 μm graded index fiber, 6 dB/km fiber attenuation at 700 nm, 170 ps/nm-km material dispersion, a negligible contribution from fiber modal bandwidth (>200 MHz/km at 700 nm), and a fluor efficiency at 700 nm of 0.43 × Liquid A at 540 nm.

Experimental data on system response time and dynamic range as a function of fiber length will be presented for four different fluor-fiber systems. In addition, fluor formulation and response time data shall be given.

REFERENCES

1. P.B. Lyons, et al, "Sub-Nanosecond Plastic Scintillators," *IEEE, NS-24*, No. 1, (February 1977).

2. P.B. Lyons, L. Franks, and S. Lutz, "The Development of Fast Liquid Scintillators for Fiber Optic Applications," *Scintillation Counting Recent Application and developments*, 2, Academic Press (1980).

3. Kodak dye #14567. 4-dicyanomethylene-2-methyl-6-p-dimethylaminostyryl-4H-pyran.

4. Exciton Chemicals. Coumarin-540A-1,2,4,5,3H,6H,10H-tetrahydro-8-trifluoromethyl(1)benzopyrano(9,9a,1-gh)quinolizin-10-one.

5. P.B. Lyons, et al, "Fiber Optic Applications in Nuclear Testing," Electro-Optics/Laser Conference, Anaheim, California (October 23-25, 1979).

6. 2-phenyl-5-(4-biphenyl)-1,3,4 oxadiazole, 8 g/ℓ, plus tetraphenylbutadiene, 8 g/ℓ, in psuedo-cumene.

7. P.B. Lyons, et al, "The Utilization of Fiber Optics in Radiation Diagnostics," presented at Fiber Optics and Communications Exposition, Chicago, Illinois, Los Alamos National Scientific Laboratory Report LA-UR-78-1860 (September 1978).

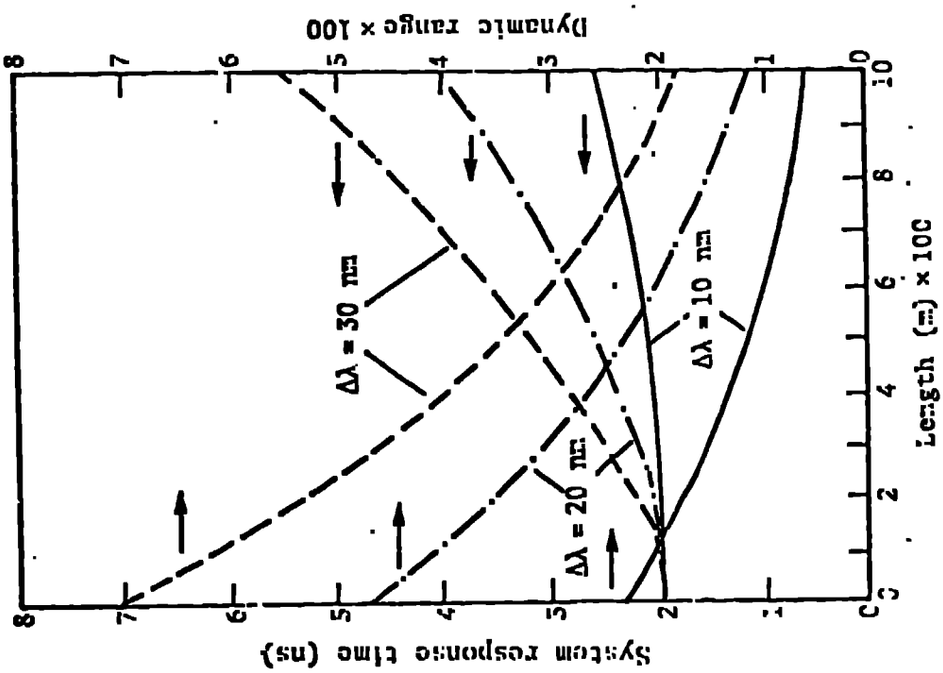

Figure 2. Time response and dynamic range for a system utilizing 700 nm emitting fluor based on Kodak dye #14567

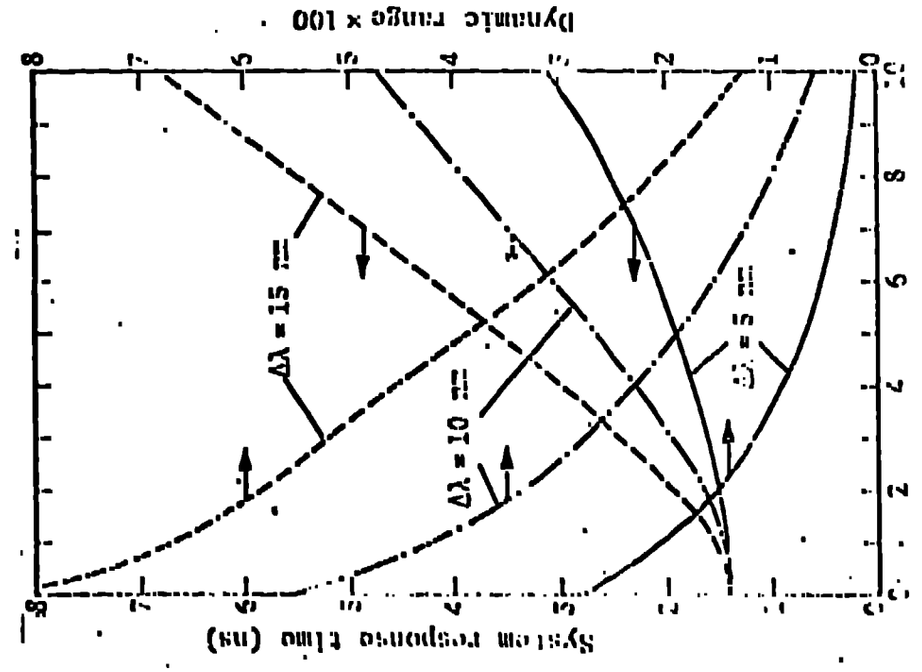

Figure 1. Time response and dynamic range for a system utilizing Liquid A at 540 nm